# Treatment of complex tibial plateau fracture associated with anterior tibial tubercle involvement

Sebastián Pereira, Gabriel Vindver, Fernando Bidolegui

*Orthopedics Department, Hospital Sirio Libanés, ECICARO, Ciudad Autónoma de Buenos Aires*

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## Abstract

**Introduction:** Fractures in both tibial plateaus occur following high-energy traumatisms. Sometimes, fracture can compromise the tibial tubercle. Neither the Schatzker nor the AO/OTA classifications take this fragment into account. The aim of this study was to describe incidence and surgical management in these types of fractures.

**Materials and Methods:** We carried out a retrospective study between 2009 and 2017 which included 48 fractures in both tibial plateaus treated with reduction and osteosynthesis; 10 of them showed a fragment of the tibial tubercle associated. Seven patients were males, whereas 3 of them were females. Patients averaged 33.5 years old. Nine of them received initial stabilization by external fixator. The fragment of the tibial tubercle was fixed using 2 3.5-mm screws (9 cases) and 1/3 tubular plate (one case). One patient had suffered an open fracture. Minimal follow-up was 12 months.

**Results:** We got bone healing in all the cases. There were no infections. Knee ROM was 10º-extension (0º-20º) and 120º-flexion (90º-140º). In one case it was necessary to remove the osteosynthesis material. One patient required arthroscopy to treat a meniscal injury.

**Conclusions:** In our series, 20.8% of all fractures in both tibial plateaus showed one fragment from the tibial tubercle. The fixation of this fragment with 3.5-mm screws or a 1/3 tubular plate is an effective technique to get adequate stabilization for the fragment.

**Key words:** Tibial plateau fracture; tibial tubercle; complex fracture in proximal tibial bone.

**Level of evidence:** IV

### Tratamiento de las fracturas complejas de platillo tibial con compromiso de la tuberosidad anterior de la tibia

## Resumen

**Introducción:** Las fracturas de ambos platillos tibiales ocurren por traumatismos de alta energía. A veces, pueden comprometer el tubérculo anterior de la tibia. Ni la clasificación de Schatzker ni la de la AO/OTA consideran la presencia de este fragmento. El objetivo de este estudio fue describir la incidencia y el manejo quirúrgico de este tipo de fracturas.

**Materiales y Métodos:** Se realizó un estudio retrospectivo, entre 2009 y 2017, que incluyó 48 fracturas de ambos platillos tratadas con reducción y osteosíntesis, 10 presentaban un fragmento de la tuberosidad anterior asociado. Siete pacientes eran hombres y 3, mujeres. La edad promedio era de 33.5 años. Nueve fueron estabilizadas inicialmente con tutor externo. El fragmento de la tuberosidad se fijó con 2 tornillos de 3,5 mm (9 casos) y con una placa 1/3 de tubo (un caso). Un paciente tenía una fractura expuesta. El seguimiento mínimo fue de 12 meses.

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**Resultados:** En todos, se logró la consolidación ósea. No hubo infecciones. El rango de movilidad de la rodilla logrado fue de 10º de extensión (rango 0-20º) a 120º de flexión (rango 90-140º). En un caso fue necesario retirar el material de osteosíntesis. Un paciente requirió artroscopia para tratar una lesión meniscal.
**Conclusiones:** El 20,8% de las fracturas de ambos platillos tibiales presenta un fragmento de la tuberosidad anterior de la tibia, según nuestra serie. La fijación de este fragmento con tornillos de 3,5 mm o una placa 1/3 de tubo bloqueada es una técnica eficaz para lograr una estabilidad adecuada del fragmento.

**Palabras clave:** Fractura de platillo tibial; tuberosidad anterior; fractura compleja de tibia proximal.
**Nivel de Evidencia:** IV

## Introduction

Fractures in both tibial plateaus usually occur following high-energy traumatisms. These ones are Schatzker classification V and VI type fractures,[1] or AO/OTA classification 41C type fracture.[2] However, as the case is in fractures involving the PM fragment of the medial tibial plateau, fractures associated with the fragment of the tibial tubercle (TTF) are not individualized in either of the two most accepted classifications. The incorporation of CT scan and a more three-dimensional vision of the fracture have helped understand better these complex injuries.[3-6] The presence of one TTF in association with fracture in both tibial plateaus requires special thinking about surgical approach, fixation and postoperative management, which should be taken into account at the time of treatment. The aim of this study is to communicate the incidence and surgical treatment of these types of fractures.

## Materials and Methods

We evaluated in a retrospective way the patients with tibial plateau fracture treated at the Orthopedics Department we work at between January 2009 and January 2017. Inclusion criteria were: fracture in one or both tibial plateaus with associated TTF treated with plates and screws osteosynthesis. We excluded those patients with a <6-month postoperative follow-up, those younger than 18 years old at the time of treatment, and those treated

**Table.** Patients' characteristics

| Case | Age | Fracture* | Soft tissues** | Fixation of lateral plateau | Fixation of medial plateau | Fixation of tibial tubercle |
|---|---|---|---|---|---|---|
| 1 | 43 | VI | T II | Anatomic lateral plate | | 3.5-mm screws |
| 2 | 38 | VI | T I | Anatomic lateral plate | 3.5-mm wrist plate | 3.5-mm screws |
| 3 | 41 | VI | T II | Anatomic lateral plate | 3.5-mm reconstruction plate | 3.5-mm screws |
| 4 | 27 | V | CS/Gustilo 3A | 4.5-mm LCP | | 3.5-mm screws |
| 5 | 26 | V | T I | Anatomic lateral plate | 1/3 tubular plate | 3.5-mm screws |
| 6 | 41 | VI | T II | Anatomic lateral plate | 1/3 tubular plate | 3.5-mm screws |
| 7 | 31 | V | TI | Anatomic lateral plate | 3.5-mm PM plate | 3.5-mm screws |
| 8 | 21 | VI | T II | Anatomic lateral plate | 3.5 mm wrist plate | 3.5-mm screws |
| 9 | 31 | V | T I | Anatomic lateral plate | 1/3 tubular plate | 3.5-mm screws |
| 10 | 34 | IV | T II | | 3.5-mm reconstruction plate | 1/3 tubular plate |

* Schatzker classification, ** Tscherne classification, CS = compartment syndrome, PM = specific plate for PM fragment.

conservatively or with a surgery other than osteosynthesis with plates and screws. Out of 48 patients with fracture in both tibial plateaus subject to reduction plus osteosynthesis with plates and screws, 10 (20.8%) had a TTF associated. Five (50%) were classified as Schatzker's VI types; four (40%), as Schatzker's V types, and one (10%) with medial tibial plateau fracture in association with TTF, as a IV type. The patients averaged 33.5 years of age (ranging from 21 to 43). Seven patients were males and three, females. The mechanism of injury was motor-crash in eight cases (80%) and fall from own height in the other two (20%). At admittance all the patients were evaluated by AP and lateral X-rays, and a CT scan was carried out after external fixation. Thee patients (30%) had another skeletal injury associated (ipsilateral acetabular fracture [1 case], and upper-limb fracture [2 cases]). One of the fractures (10%) was open (Gustilo 3A type[7]) and it was associated with compartment syndrome; therefore, it was initially treated with surgical toilet, stabilization by external fixator and fasciotomy. The remaining fractures (90%) were closed fractures, and soft tissues lesions were classified as Tscherne[8] I types (5 cases) and II types (4 cases) (Table). In all the patients but one we carried out initial temporary fixation with trans-articular external fixator for better management of soft tissues.[9,10] The average time between fracture and definite surgery was 9 days (ranging from 5 to 21). For definite fixation we waited edema resolution and the presence of the "wrinkle sign".

Minimal follow-up in the series was 12 months.

### *Surgical management*

In 8 out of the 10 cases we used double approach, associating an AL approach with a PM or medial approach and, only in Case # 10, we resorted to a medial approach associated with a little anterior approach. In the two remaining cases (22%), fractures in both tibial plateaus were fixed with just one lateral plate inserted through a unique AL approach. Fixation in the lateral tibial plateau was carried out with 3.5-mm proximal tibial anatomic locking plates in 8 out of the 9 cases (89%), and with one 4.5-mm LCP in the remaining patient (11%). In 7 out of the 9 cases (78%), we used a second plate apart from the lateral one for fixation of the medial tibial plateau. Since fracture lines were on the coronal plane, in five of them we used 3.5-mm wrist plates inserted through PM approaches (2 cases); 3.5-mm 1/3 tubular plates (2 cases) and one specific 3.5-mm plate for the PM fragment (1 case). In the two remaining cases, since the fracture line was on the sagittal plane, we carried out fixation with 3.5-mm reconstruction medial plates with minimally-invasive techniques on the medial aspect of the bone (Figure 1). After fixation of the lateral tibial plateau we carried out TTF reduction with forceps or other specialized devices and consecutive fixation with 3.5-mm cortex screws or plates depending on the size and fracture line pattern of the fragment. In 9 out of the 10 cases (90%) we used only screws for fragment fixation.

The number of screws was two in all the cases. In six of them, screws were inserted through the same AL approach, whereas in three cases, they were inserted percutaneously. In the remaining patient (Schatzker's IV type fracture), it was necessary to carry out a small anterior approach for TTF reduction and fixation with a 5-hole 3.5-mm 1/3 tubular plate (Figure 2). The postoperative protocol consisted of early passive knee flexion-extension and active flexion as tolerated. Active extension was delayed until postoperative week six. Weight-bearing on the affected limb started as of postoperative week 12 on the grounds of patients' radiographic results.

## Results

We achieved bone healing in the 10 cases (100%). Only one patient suffered a little secondary TTF displacement before bone healing as compared with their initial surgical checkup. The patients' knee ROM was 10º-extension (ranging from 0º to 20º) and 120º-flexion (ranging from 90º to 140º). There was no infection. Two patients (20%) required a second programmed surgery: one for implant removal because they reported discomfort in both the TTF area and their knee lateral aspect, whereas another one was subject to knee arthroscopy due to persistent pain, in which we treated a meniscal injury. Nine out of the 10 patients returned to previous work activities, and just one had to be re-assigned.

## Discussion

The systematic study of CT scan from patients with fracture in both tibial plateaus, as well as a better understanding of the morphologic characteristics of fracture patterns have individualized those fractures with TTF.[3-6] This injury pattern is equivalent to disruption in the knee extensor system, with which it should be identified and taken into account at the time of surgical treatment.

The studies that evaluated this pattern (TTF) in fractures of both tibial plateaus report a 16%-21.6% incidence of all knee fractures with compromise of both tibial plateaus.[3-6] In our series, TTF incidence was 20.8%, figures that coincide with those in publications by different authors.

The presence of a TTF requires stable fixation of the fragment, what, depending on the fracture pattern, can be achieved by interfragmentary compression screws[11] or by screws in association with plates.[5,7] What is more, some authors report success with wire loop fixation.[12]

In 2009, Chakraverty et al. published results in TTF fixation with wire loop in their series of 16 patients with


**Figure 1.** Forty-one year-old female with Schatzker's VI fracture. **A-C.** After initial stabilization with external fixation we carry out reduction and osteosynthesis through an AL approach (**D and E**) and a minimally-invasive medial approach (**F**). The fixation of the tibial tubeorisity fragment with a 3.5-m screw is carried out percutaneously. **G and H.** Long-term postoperative X-rays.

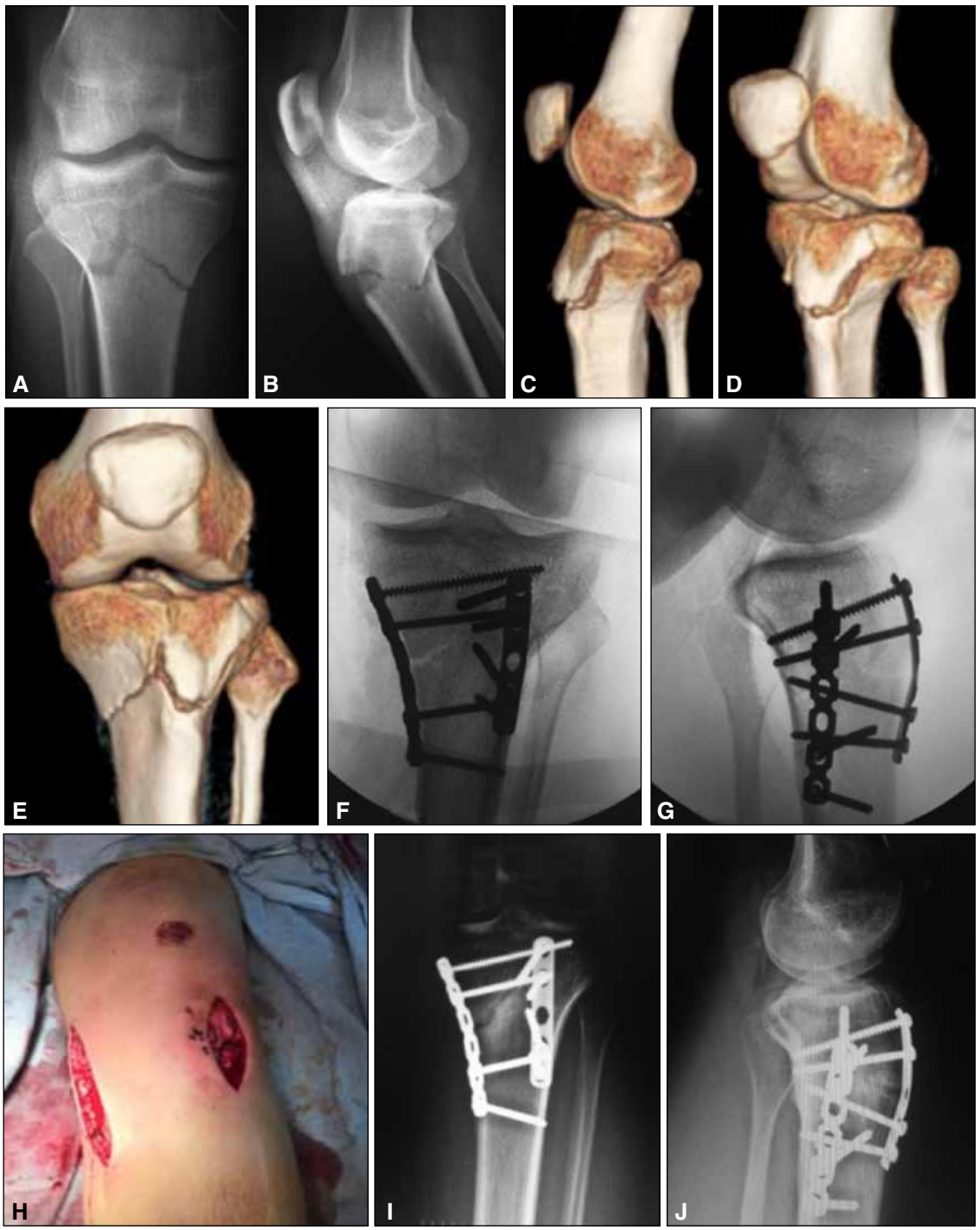


**Figure 2.** Case 10. **A-E.** Thirty-four year-old male with Schatzker's IV proximal tibial fracture associated with fragment from tibial tubercle. **F-H.** Fixation of the medial tibial plateau with a 3.5-mm reconstruction plate and fixation of the tibial tubercle fragment with a 1/3 tubular plate through media and anterior approaches, respectively. **I and J.** 6th-month postoperative X-rays showing bone healing.

fracture in both tibial plateaus. These authors affirm that this technique provides the fracture with stable fragment fixation independently of the status of the posterior cortex and, moreover, it avoids the "traffic" of screws which may hinder fixation with compression screws.[12] In 2013, Maroto et al. in the largest series (84 patients) of fracture in both tibial plateaus in association with TTF use, depending on the status of the posterior cortex of the proximal tibial bone, screws in isolation or one plate with screws for the fixation of the fragment. If the posterior cortex in which the screw

is fixed is undamaged, they choose to use only 2.7-mm or 3.5-mm screws; however, when the posterior cortex is insufficient or there is comminution, they use screws associated with a 3.5-mm 1/3 tubular plate or a 2.0-mm DCP.[13]

In 2004, Ricci et al. described a series of 24 patients with complex fracture in tibial plateau treated with plate; three of them required the specific fixation of the TTF with 3.5-mm interfragmentary compression screws.[11] In our series, in 9 out of the 10 cases we used only screws for TTF fixation and, only in one case, we opted for one plate due to comminution and the size of the fragment.

Soft tissues coverage in scarce on the tibial tubercle; therefore, the approach should be very careful, trying to carry out as little soft-tissue release as possible.

Maroto et al. report that 7.1% (6 cases) required an additional anterior approach for TTF fixation.[13]

In our series it was necessary to carry out a specific anterior approach for the reduction and fixation of the TTF in only one patient (10%). Fixation with screws was always carried out through the same AL approach or percutaneously.[14] The main limitations of this study are its retrospective character and the small number of patients in the series. On the other hand, we highlight as a study's strength that the technique we used for TTF fixation was the same in all the cases.

## Conclusions

In our series we verified TTF in 20.8% of all fractures in both tibial plateaus. Therefore, it is essential to evaluate the presence of this fragment in patients with fracture in both tibial plateaus, since they require specific treatment. The fixation of the TTF with 3.5-mm screws or a 1/3 tubular plate is an effective technique to get adequate stabilization for the fragment.

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